PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Projection Screen.

I, TAKEO SHIMIZU, a Subject of the Emperor of Japan, residing at No. 57, Komagome Sendagi-cho, Hongo-ku, Tokyo, Japan, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to a projection screen, and has for its object to obtain a screen by which only the light from the projector is scattered, while the light from other sources is nearly entirely absorbed so that it does not make any hindrance to the projection.

It has heretofore been proposed to provide a projection screen one surface of which is composed of an aggregate of an immense number of minute optical systems lying side by side, each of which will condense parallel rays of light falling upon its area into a point, and the other surface of the screen is so blackened that it is transparent only at parts where the light from a projection lamp, which is to be placed at a definite position with regard to the screen, converges after passing through each of the numerous optical systems stated above, the rest of the surface being entirely black so as to absorb any light falling upon it.

According to the present invention the blackened surface of the screen is either composed of a film of photographic emulsion, which is attached to the back surface of the screen in a dark place, exposed to the light of a blank projector situated at approximately the same position relative to the screen as when the screen shall be in use, and subjected to the process of development and chemical reversal, or is composed of a photolithographical copy of a film produced by the above automatic process.

The annexed drawings illustrate one example of carrying out the invention.

In the drawings,

Fig. 1 is a sectional elevation of a transmitting screen illustrating its action in a very large scale,

Fig. 2 is a similar sectional elevation of a reflecting screen,

Fig. 3 is an enlarged view of a portion of the surface of the screens shown in Figs. 1 and 2, and

Fig. 4 is a diagrammatical view illustrating one step of the manufacture of the above screens.

Similar parts are represented by similar symbols throughout the drawings.

Referring to the drawings the construction of the projection screen is explained by the following example of its preparation.

The front layer of the screen is composed of a sheet (1) Figs. 1 and 2, of some transparent material such as celluloid or glass, whose front surface (2) is so moulded that the entire sheet forms an aggregate of an immense number of minute condensing lenses as shown in Fig. 3 in their front view. Strictly speaking, the shape of each of the protrusions given to the front surface ought to be a Cartesian oval, namely a prolate spheroid with suitable eccentricity and with its principal axis in the direction of the incident parallel rays.

The thickness of the sheet (1) is chosen differently according to the mode of use of the screen. In the case of the transmitting screen (having observers and the projector on the opposite sides of the screen) shown in Fig. 1, the thickness is so determined that the practically parallel rays of light falling upon each condensing lens converge to a point on its back surface (3). In the case of the reflecting screen (having observers and the projector on the same side of the screen) shown in Fig. 2, the thickness is made smaller, so that the rays would virtually converge to a point on a plane (8) behind the back surface (3).

The sheet (1) is then brought into a dark room, and its back surface is coated with photographic sensitive film (4). The entire sheet so formed (A in Fig. 4) is suspended vertically, with its front moulded surface (2) facing a projector (B in Fig. 4), at a definite distance from the latter. The projector is lighted for an instant, leaving its picture-frame vacant, so as to make only the areas (5) on the sensitive film, where the rays from the projector converge, developable. The

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film is then subjected to the process of development and chemical reversal, so as to make only the exposed areas (5) transparent and the rest black.

The sheet is brought out of the dark room, and the preparation is finished in the following manner. In the case of the transmitting screen shown in Fig. 1, a film (6) of some transparent material, whose back surface is very minutely uneven or of whitish semi-transparent material, is adhered to the rear of the above sheet, and in the case of the reflecting screen shown in Fig. 2, a film (7) of silver or of some white material is adhered to the rear of the sheet and some protective material is spread over the film (7).

The photographic process of preparing the blackened surface explained above is an essential point of the present invention, but when once a surface is prepared by this process, a large number of copies may be produced by means of photolithographic methods, and used in place of the actual photographic film so long as the front layers of optical systems are made out of the same mould.

The screen so prepared is suspended upright, with its front surface (2) facing the projector, and at approximately the same position relative to the projector as in the photographic process, and the picture is projected on the screen in the daylight. The optical effect of the screen is as follows.

In the case of the transmitting screen shown in Fig. 1, the rays (a), (b), (c) etc. of light coming from the projector converge to the transparent spot (5) of the photographic film, as is evident from the mode of preparation, pass the spot and diverge, and the rays finally are scattered by the minutely uneven surface of the film (6) to all directions behind the screen as groups of rays (a^1), (b^1), (c^1) etc. The rays (d), (e), (f) etc., which come from walls and are accordingly injurious to the purpose of projection, converge and hit some dark part (5^1) of the photographic film and are absorbed therein. Some rays like (g), which come very obliquely from the walls, may pass through an adjacent transparent part as indicated, in Fig. 1. But as the solid angle such rays subtend is small, they are generally not so injurious. Any light incident upon the screen from the back side, i.e. from the side of observers in the present case, are practically entirely absorbed by the seemingly black photographic film. Whenever there are some very strong extraneous sources of light, their direct effect upon the screen must be avoided by hanging a sheet of black cloth in the mid-way.

In the case of the reflecting screen shown in Fig. 2, which is silvered on the back surface, the rays (a), (b), (c) etc. of light coming from the projector are reflected at the transparent spot (5) by the reflecting film (7), which lies in front of the virtual focal plane (8), and consequently escape the lens-surface (2) not as parallel rays but as divergent rays like (a^1), (b^1), (c^1) etc. As the transparent parts (5) of the photographic film are not very small spots in the present case, the diffuse light coming from the vicinity of the projector is partly reflected and scattered to the front side of the screen, where the observers are situated. Thus it is necessary to hang a piece of black cloth behind the projector. But diffuse rays (d), (e), (f) etc. coming from directions much different from those of the projected light are entirely absorbed by the dark part of the photographic film. As to the diffuse light incident very obliquely to the screen, the circumstance is about the same as in the case of the transmitting screen.

In the case of the reflecting screen with white material instead of silver on the back surface, it is not easy to indicate the exact paths of the reflected rays, but it is evident that the general tendency is similar to that explained in Fig. 2.

In either kind of the screens, the rays from the projector incident upon the marginal part of the screen are scattered in the main outwardly from the [illegible] axis normal to the screen. In order to remedy this undesirable effect, the following plan may be adopted (not indicated in the figures). In the case of the transmitting screen, the backmost, minutely uneven surface may be made inclined by small areas somewhat like the surface of a scale-armor, so that the film (6) of transparent material forms an aggregate of minute prisms each refracting the light from one condensing lens. Similarly, in the case of the silvered reflecting screen, the silvered surface may be made inclined by small areas so that it forms an aggregate of minute inclined mirrors. The angles of inclination may be so determined that the scattered rays from every part of the screen cover the area to be occupied by the observers.

As is clear from the above explanation, the merit of the present invention is that the daylight screen absorbs practically all the diffuse light injurious to the purpose of projection, scattering selectively all the light coming from the projector. Consequently the screen appears dark in the daylight, except at places which correspond to the bright part of the

picture, and the object of daylight-projection is attained. It is also an advantage of the present invention that the screen may be manufactured easily once the original mould is constructed.

The above illustration is one embodiment of my invention and the invention is not limited by the same, so that the constructions and arrangements of detailed parts may be changed without departing from the spirit of the invention.

One typical example of such alterations may be mentioned. A cylindrical lens, say a glass-rod, condenses parallel rays of light into a line. Two such lenses set at right angles, one behind the other, condense parallel rays of light incident upon the crossed area nearly into a point. Hence, two gratings, each composed of a great number of slender cylindrical lenses, piled on at right angles to each other, condense light falling upon the area into a square aggregate of points. So that the system of small circular lenses illustrated in the figures may be replaced by a pile of two such gratings. The blackening must naturally be effected on the back surface of each grating in this case, a system of parallel lines where the rays from the projector converge being left transparent.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A projection screen, in which, the front surface of the screen is composed of an aggregate of an immense number of minute optical systems to condense practically parallel rays of light to a point, and the back surface of the screen is so blackened that only the spots, where the light from the projector, which is to be placed at a definite position with regard to the screen, converge after passing each of the above optical systems, is transparent, the rest of the surface being entirely black so as to absorb any light falling upon it, characterised by the fact that the blackened surface is either composed of a film of photographic emulsion, which is attached to the back surface of the screen in a dark place, exposed to the light of a blank projector situated at approximately the same position relative to the screen as when the screen shall be in use, and subjected to the process of development and chemical reversal, or is composed of a photolithographical copy of a film produced by the above automatic process.

2. A projection screen according to claim 1, in which a film of transparent material with a minutely uneven surface or of semi-transparent material is attached to the back surface of the screen, so that the scattering of the light from the projector is enhanced and the screen can be used as a transmitting daylight screen.

3. A projection screen according to claim 1, in which a film of silver or of some white material is attached to the back surface of the screen, so that the light from the projector is reflected and the screen can be used as a reflecting daylight screen.

4. A projection screen according to claim 1, in which the back surface of the screen is made inclined by small areas, so that the film for enhancing the scattering of light described in claim 2 forms an aggregate of minute prisms, each refracting and scattering most of the light into desirable directions.

5. A projection screen according to claim 1, in which a pile of two gratings, each composed of an immense number of cylindrical lenses, set at right angles to each other, is used as the condensing optical system.

Dated this 19th day of January, 1932.

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Fig. 1

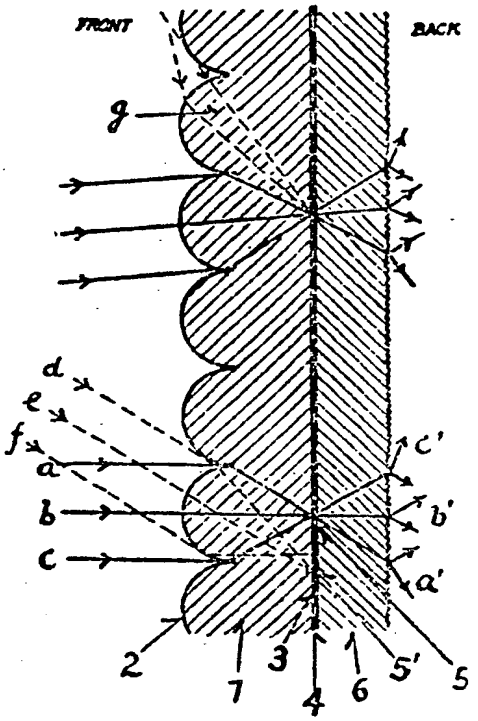


Fig. 2

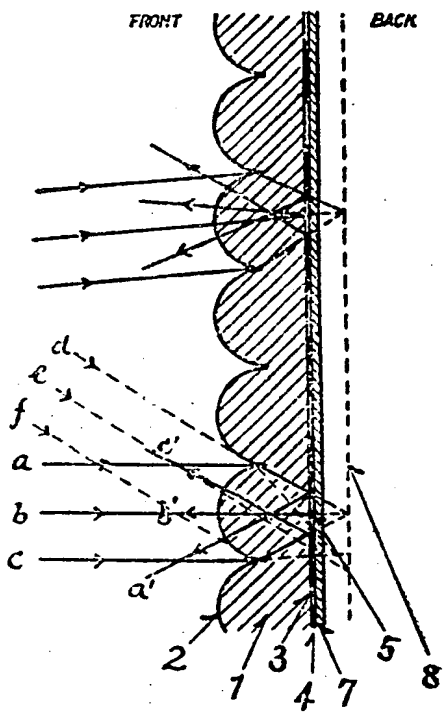


Fig. 3

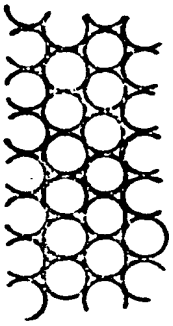
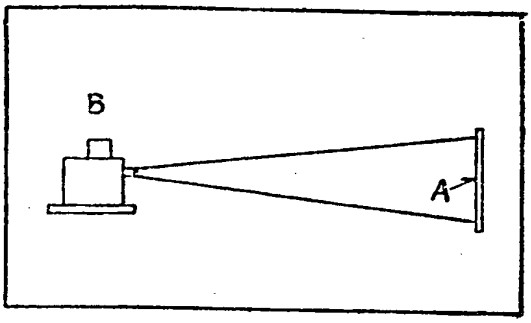


Fig. 4



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